

## CLAIMS

I Claim:

1. A scanning electron microscope comprising:

a particle beam imaging column;

air bearings supporting the particle beam imaging column atop a working surface; and

staged vacuum seals coupled to the imaging column between the column and the working surface for maintaining at least a first predefined area of the working surface in a vacuum environment.

2. The scanning electron microscope of claim 1 wherein the working surface further contains a test object planarizing means, the test object planarizing means accepting a test subject and placing an upper surface of the test object into a co-planar relationship with the working surface.

3. The scanning electron microscope of claim 2 wherein the planarizing means comprises a first air bearing unit, the air bearing unit comprising a plurality of air bearings within a frame, so that the air bearings are held in a fixed and co-planar relationship to one another and a test object holding means, the test object holding means accepting a test object, grasping and then holding the test object in a co-planar relationship with the top surface when the air bearing unit presses and fixes the test object against the test object holding means.

4. The scanning electron microscope of claim 3 wherein the test object holding means further comprises a vacuum chuck and a plurality of lifter assemblies.

5. The scanning electron microscope of claim 4 wherein the lifter assemblies are spring-loaded, initially biased to an extended, test object receiving position and compressed into a second, test object holding position by the first air bearing unit.

6. A particle beam device which operates upon a test subject, wherein at least a portion of the particle beam device is maintained in a vacuum, the particle beam device comprising at least:

a particle generator;

at least a first particle focussing device, the particle generator and the at least first particle focussing device together being formed into a first particle beam column; and

a plurality of air bearings to support the particle beam column and to permit the particle beam column to move in a nearly frictionless manner across a top surface of a first support table.

7. The particle beam device wherein a staged vacuum seal is fitted to the particle beam column between the at least first particle focussing device and the top surface of the first support table, the staged vacuum seal creating a plurality of concentric, reduced pressure zones around the first particle beam column.

8. The particles beam device of claim 7 wherein the staged vacuum seal is comprised of a plurality of nested circles, the innermost reduced pressure zone having a circular cross section and succeeding reduced pressure zones have a torroidal cross section surrounding the innermost circular reduced pressure zone.

9. The particle beam device of claim 8 wherein the innermost circular reduced pressure zone has a first predefined air pressure that permits operation of the particle beam within the innermost circular reduced pressure zone.

10. The particle beam device of claim 9 wherein each succeeding torroidal reduced pressure zone has an air pressure greater than the preceding reduced pressure zone.

11. The particle beam device of claim 7 wherein a sample holding station is located within the top surface of the first support table, the sample holding station holding at least a first surface of a test object in an essentially co-planar relationship with the top surface of the first support table.

12. The particle beam device of claim 11 wherein the test object comprises a semiconductor wafer of first predetermined diameter and the sample holding station comprises at least a circular well of first predetermined diameter in the top surface of the first support table.

13. The particle beam device of claim 12 wherein the sample holding station further comprises a plurality of lifter assemblies and a vacuum chuck, the lifter assemblies in a first extended position receiving the semiconductor wafer and in a second, compressed position holding the semiconductor wafer in proximity to the vacuum chuck so that the vacuum chuck can hold the semiconductor wafer, the compressed position being such that the top surface of the semiconductor wafer is held in a co-planar relationship with the top surface of the first support table.

14. The particle beam device of claim 13 wherein a air bearing leveling tool is used to place the semiconductor wafer into the second, compressed position, the tool comprising a plurality of air bearings fixed into a rigid frame, an active, gas bearing surface of each of the air bearings being held in a co-planar relationship with all the other active, gas bearing surfaces of the air bearings, the frame having a predetermined diameter greater than the semiconductor wafer's diameter, the active, gas bearing surfaces being applied to the top surface of the semiconductor wafer and forcing the wafer and the lifter assemblies into the second, compressed position during operation of the particle beam device.

15. The particle beam device of claim 14 wherein the lifter assemblies are filled with a low melting point metal alloy, heat being applied to the lifter assemblies when the lifter assemblies are required to move from the first position to the second position and when the lifter assemblies are required to move from the second position to the first position, heat being removed and the metal alloy solidifying, fixing the lifter assemblies into position at all other times.

16. A method to facilitate the use of a particle beam device with an object having a first surface, the method comprising the steps of:

supporting the particle beam device so that it is capable of substantially frictionless motion over a first surface;

placing the first surface of the object in a co-planar relationship with the first surface; and

moving the particle beam generated by the particle beam device over the first surface of the object while the first surface is held in its co-planar relationship with the first surface.

17. The method of claim 16 wherein a plurality of air bearings are attached to the particle beam device and permit its substantially frictionless motion over the first surface.

18. The method of claim 17 wherein a staged seal vacuum generator is attached to the particle beam device so that the particle beam device will continue to operate in a substantial vacuum even while moving over the first surface.

19. The method of claim 18 wherein the first surface comprises a first, device-fabrication side of a semiconductor wafer.